

Homework 3 Report

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Newly Added APIs Description:

API (`NeuralNetwork`)

`[nil] backward([ND FloatTensor] target)`

The Backward Propagation method that takes in the target, and do the calculations of delta, and $\partial E / \partial \Theta$. Note that for hidden layers, the first dimension of delta is removed before back-propagating to the front layer.

`[nil] updateParams([float] eta)`

Update the training weights by deducting $\eta * (\partial E / \partial \Theta)$ from the weights in the last training epoch. The eta is used as element wise multiplication.

API (`logicGates`)

`[nil] AND.train()`

`[nil] OR.train()`

`[nil] NOT.train()`

`[nil] XOR.train()`

The training function for AND, OR, NOT, and XOR gate. Each input is randomized as combinations of x in (0, 1) and y in (0, 1). The target is verified by python's "and", "or", and "not". For XOR, the target is [(x and (not y)) or ((not x) and y)].

Note that target is converted from boolean values to float values for computation.

How to run:

\$ python test.py

Result:

It is shown that the trained weights performs correctly and output expected boolean results.

```

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tensor([[ -5.9105,  3.8190,  3.8172]])
===== Test cases for AND =====
AND(False, False) = False
AND(False, True) = False
AND(True, False) = False
AND(True, True) = True

tensor([[ -1.9710,  4.5115,  4.4516]])
===== Test cases for OR =====
OR(False, False) = False
OR(False, True) = True
OR(True, False) = True
OR(True, True) = True

tensor([[ 2.7776, -5.7122]])
===== Test cases for NOT =====
NOT(False) = True
NOT(True) = False

tensor([[ -3.5787, -6.5990,  6.4673],
        [-3.3105,  5.9958, -6.2254]])
tensor([[ -5.0930, 10.2340, 10.3557]])
===== Test cases for XOR =====
XOR(False, False) = False
XOR(False, True) = True
XOR(True, False) = True
XOR(True, True) = False
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```

Analysis:

By comparing the trained weights with the predefined weights in **Homework 02**, I found out they are relatively the same, which is as expected.

Gates	HW2 Theta (Predefined)	HW3 Theta (Trained)
AND	$\begin{bmatrix} -3 & 2 & 2 \end{bmatrix}$	$\begin{bmatrix} -5.9105 & 3.8190 & 3.8172 \end{bmatrix}$
OR	$\begin{bmatrix} -2 & 3 & 3 \end{bmatrix}$	$\begin{bmatrix} -1.9710 & 4.5115 & 4.4516 \end{bmatrix}$
NOT	$\begin{bmatrix} 0 & -1 \end{bmatrix}$	$\begin{bmatrix} 2.7776 & -5.7122 \end{bmatrix}$
XOR	$\begin{bmatrix} -2 & 3 & -3 \\ -2 & -3 & 3 \end{bmatrix}$	$\begin{bmatrix} -3.5787 & -6.5990 & 6.4673 \\ -3.3105 & 5.9958 & -6.2254 \end{bmatrix}$
	$\begin{bmatrix} -2 & 3 & 3 \end{bmatrix}$	$\begin{bmatrix} -5.0930 & 10.2340 & 10.3557 \end{bmatrix}$